



LM Lightning Protection

A short description.

Introduction

Using the latest standard for lightning protection in the aviation industry, LM Glasfiber has conducted a large number of full-scale trials in the largest lightning laboratory in the world. These trials have led to LM Glasfiber developing a new lightning protection system. The system comprises a patented tip end receptor with an integrated drain called a DrainReceptor, a series of special receptors called MultiReceptors on each side of the blade, and a conductive cable connected to the turbine's other lightning protection system, and located in the middle of the blade. In the event of a lightning strike, this conducts the lightning charge from the blade to the turbine tower, which is earthed.

LM Lightning protection system:

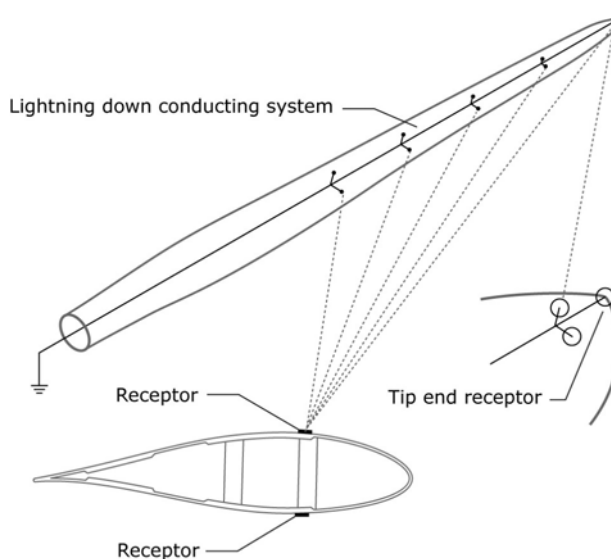
LM Glasfiber lightning protection system were developed and designed to conform with the international CEI/IEC protection level 1 standards. This corresponds to protection against 98% of all commonly occurring lightning strikes.

Table 1: Relationship of lightning current parameters to protection levels

Selected lightning	Protection level		
	1	2	3
Current peak value I (kA)	200	150	100
Total charge Q_{total} (C)	300	225	150
Specific energy W/R (kJ/Ω)	10 000	5 600	2 500
Average steepness $kA/\mu s$	200	150	100

Source: CEI/IEC 61024-1-1

Fig. 1 Sketch of the new LM Lightning Protection System



Component description

Receptors:

Receptors are the points of conduction where the lightning actually strikes the blade. These receptors are manufactured from a special alloy that has excellent conductive qualities and is resistant to intense heat.

With repeated lightning strikes, the surface of the receptor will partly evaporate, but the alloy ensures that these receptors can withstand several strikes before they need to be replaced. Due to its simple construction, the lightning receptor is easy to replace if necessary.

DrainReceptor:

The DrainReceptor is one component in the entire lightning protection system. Experience shows that the area around the tip of the blade is the section of the turbine that receives the most strikes, making it the most vulnerable part. With its position right at the tip of the blade, the DrainReceptor therefore helps to protect the most exposed section of the blade. The system was developed and patented by LM Glasfiber, and the DrainReceptor is constructed in such a way that it is easy to replace if necessary.

The receptor also acts as a drain hole, allowing condensation within the blade to be drained off. The receptors thus replace the drain holes that were previously built into LM Glasfiber blades. Such drain holes are necessary because condensation can form on the many square metres of surface on the inner side of the blade. If this condensation is not drained off, the rotation of the blade causes water to collect at the tip of the blade, which affects total performance.

In addition, blades that contain water run the risk of overheating in the event of a lightning strike. This results in the formation of significant vapour pressure, which can in extreme cases cause the blade to explode.

MultiReceptor:

The DrainReceptor is one of several receptors in the new multi-receptor system that LM Glasfiber now supplies for its large blades. This system consists of several receptors fitted on both the upper and lower sides of the blade. The combination of DrainReceptors and multi-receptors ensures the best possible protection of the entire blade. Each individual receptor is connected to the blade's main conductor cable, and they are designed so that each – on its own – is capable of conducting the total energy generated by a lightning strike to the main cable.

Lightning conduction system:

The lightning conduction system is the network of cables that conducts the lightning current from the receptors to the turbine's lightning protection system. After installing more than 65,000 lightning protection systems, LM Glasfiber has accumulated a wealth of experience about how to correctly conduct enormous quantities of electrical current without it short-circuiting to other conductive installations. It is equally important to ensure that the strong magnetic forces formed when the lightning current passes through the cable do not cause fittings to work loose or cause other damage to the blade and its equipment.

Lightning registration card:

LM Glasfiber is introducing new and improved lightning registration cards for future use. These resemble credit cards, and are placed at the root end of the blade, connected to the blade's lightning conduction system. The card records and documents the intensity energy content of the lightning that strikes the blade. Improved levels of sensitivity in the new card design enable it to register electrical currents in the range from approximately 5 kA to more than 200 kA. Data stored on the card can be retrieved via a special decoder available from LM Glasfiber.

Testing and documenting the lightning protection system:

There is no standardised test regarding the protection of turbine blades against lightning. LM Glasfiber has chosen to test its lightning system according to standardised procedures for aeroplane components made of composite materials. These procedures were developed by American and European aviation standardisation authorities, the SAE and EUROCAE, respectively, and formulated in the Aircraft Lightning Test Standard (Draft 27 August 2002 revision A). The system has undergone full-scale trials conducted in the largest indoor high-voltage laboratory in the world. LM Glasfiber can therefore now document the efficiency of lightning protection for the entire blade.